DACA42-02-C-0001

LOGANEnergy

Residence of Col. Johnson PEM Demonstration Program
Fort Jackson, Columbia, South Carolina
Midterm Report

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY01

Fort Jackson
Columbia, South Carolina

May 12, 2004

Executive Summary

LOGANEnergy Corporation has received a contract award from the US Army Corps of Engineers, Construction Engineering Research Lab to test and evaluate Proton Exchange Membrane (PEM) Fuel Cells at several DOD sites. Fort Jackson, SC was one of the sites awarded to LOGAN. This PEM demonstration site is now operational after the initial start-up occurred on February 20, 2003.

The personal residence of Colonel Johnson, the garrison commander was chosen for the demonstration site. It hosts a 5kW, 120vac, SU-1 PEM technology demonstration unit manufactured by Plug Power Corporation, Latham, NY. The unit operates in a grid parallel / grid synchronized configuration at 2.5kW. The unit is instrumented with an external wattmeter, Btu meter, and a gas meter. A phone line is connected to the power plant communication's modem to call-out with alarms or events requiring service and attention.

The Point of Contact for this project is Wayne Shiely, Department of Logistics and Engineering, (803) 751-2708. The estimated total energy cost savings to Ft Jackson for participating in this demonstration project is $349.48.

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Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

Residence of Colonel Brent A. Johnson PEM Demonstration Program, Fort Jackson, Columbia, South Carolina

2.0 Name, Address and Related Company Information

LOGANEnergy Corporation

1080 Holcomb Bridge Road
BLDG 100- 175
Roswell, GA 30076
(770) 650- 6388

DUNS 01-562-6211
CAGE Code 09QC3
TIN 58-2292769

LOGANEnergy Corporation is a private Fuel Cell Energy Services company founded in 1994. LOGAN specializes in planning, developing, and maintaining fuel cell projects. In addition, the company works closely with manufacturers to implement their product commercialization strategies. Over the past decade, LOGAN has analyzed hundreds of fuel cell applications. The company has acquired technical skills and expertise by designing, installing and operating over 30 commercial and small-scale fuel cell projects totaling over 7 megawatts of power. These services have been provided to the Department of Defense, fuel cell manufacturers, utilities, and other commercial customers. Presently, LOGAN supports 30 PAFC and PEM fuel cell projects at 21 locations in 12 states, and has agreements to install 22 new projects in the US and the UK over the next 18 months.

3.0 Production Capability of the Manufacturer

Plug Power manufactures a line of PEM fuel cell products at its production facility in Latham, NY. The facility produces three lines of PEM products including the 5kW GenSys5C natural gas unit, the GenSys5P LP Gas unit, and the GenCor 5kW standby power system. The current facility has the capability of manufacturing 10,000 units annually. Plug will support this project by providing remote monitoring, telephonic field support, overnight parts supply, and customer support. These services are intended to enhance the reliability and performance of the unit and achieve the highest possible customer satisfaction. Scott Wilshire is the Plug Power point of contact for this project. His phone number is 518.782.7700 ex1338, and his email address is scott_wilshire@plugpower.com.

4.0 Principal Investigator(s)

Name	Samuel Logan, Jr.	Keith Spitznagel
Title	President	Vice President Market Engagement
Company	Logan Energy Corp.	Logan Energy Corp.
Phone	770.650.6388 x 101	860.210.8050
Fax	770.650.7317	770.650.7317
Email	samlogan@loganenergy.com	kspitznagel@loganenergy.com

5.0 Authorized Negotiator(s)

Name	Samuel Logan, Jr.	Keith Spitznagel
Title	President	Vice President Market Engagement
Company	Logan Energy Corp.	Logan Energy Corp.
Phone	770.650.6388 x 101	860.210.8050
Fax	770.650.7317	770.650.7317
Email	samlogan@loganenergy.com	kspitznagel@loganenergy.com

6.0 Past Relevant Performance Information

a) Contract: PC25 Fuel Cell Service and Maintenance Contract #X1237022

Merck & Company
Ms. Stephanie Chapman
Merck & Company
Bldg 53 Northside
Linden Ave. Gate
Linden, NJ 07036
(732) 594-1686

Contract: Four-year PC25 PM Services Maintenance Agreement.
In November 2002 Merck & Company issued a four-year contract to LOGAN to provide fuel cell service, maintenance and operational support for one PC25C fuel cell installed at their Rahway, NJ plant. During the contract period the power plant has operated at 94% availability. LOGAN performs the quarterly and annual service prescribed by the UTC, and performs other maintenance as required. The periods of unavailability are chiefly due to persistent inverter problems that seem to be endemic to the Toshiba power conditioning balance of the system. Field modifications and operating adjustments have largely cured the problem. Quarterly service events take 10 hours to complete with the unit under load, and the annual event takes approximately 35 hours with the unit shut down.

b) Contract: Plug Power Service and Maintenance Agreement to support one 5kWe GenSys 5C and one 5kWe GenSys 5P PEM power plant at NAS Patuxant River, MD. .

Plug Power
Mr. Scott Wilshire.
968 Albany Shaker Rd.
Latham, NY 12110
(518) 782-7700 ex 1338

LOGAN performed the start-up of both units after Southern Maryland Electric Cooperative completed most of the installation work. The units are located at residential sites at Patuxant River Naval Air Station, VA and operate in standard gird connected/grid independent configurations. Both operate at 4.5kWe and have maintained 98% availability. The units, S/Ns 241 and 242 are two of the very latest GenSys models to reach the field. S/N 242 is Plug Power's first LPG fueled system to go into the field. Both have set a new level of performance expectations for this product, and are indicative of the success of the various test and evaluation programs that have been conducted over the past two years.

c) Contract: A Partners LLC Commercial Fuel Cell Project Design, Installation and 5-year service and maintenance agreement.
Contract # A Partners LLC, 12/31/01

Mr. Ron Allison
A Partners LLC
1171 Fulton Mall
Fresno, CA 93721
(559) 233-3262

On April 20, 2004 LOGAN completed the installation of a 600kWe PC25C CHP fuel cell installation in Fresno, CA. The system operating configurations allow for both grid parallel and grid independent energy service. The grid independent system is integrated with a multi unit load sharing electronics package and static switch, which initial development was funded by ERDC CERL in 1999. This is the third fuel cell installation that uses the MULS System. The thermal recovery package in the project includes a 100-ton chiller that captures 210 degree F waste heat supplied by the three fuel cells to cool the first three floors of the host facility. The fuel cells also provide low-grade waste heat at 140 degrees F that furnishes thermal energy to 98 water source heat pumps located throughout the 12-story building during the winter months.

7.0 Host Facility Information

Fort Jackson, located in Columbia, South Carolina is home to the largest and most active Initial Entry Training Center in the United States Army. It provides basic combat training for half of all Army Soldiers and 69 percent of all female Soldiers entering the United States Army. There are more than 52,000 acres and 53 ranges and field training sites. Fort Jackson supports several other training missions, including two Advanced Individual Training schools, the United States Army Soldier Support Institute, the United States Army Chaplain Center and School, and the Department of Defense Polygraph Institute.

The fort was established on June 2, 1917 as an Army Training Center in response to the need for trained men in World War I. It was first known as the Sixth National Cantonment out of the sixteen designated to support the war effort, and later renamed as Camp Jackson, in honor of Major General Andrew Jackson.

Fort Jackson's utility provider is South Carolina Electric and Gas who provides both electricity and natural gas to the base. City water is provided to the base by the City of Columbia.

8.0 Fuel Cell Installation

In February 2002, DCH Enable, who was to provide the fuel cell for FT. Jackson, notified LOGAN that they would not be able to fill the order. Fortunately, Plug Power agreed to fill the need, and LOGAN subsequently contracted with Plug to supply a 5kW GenSys5C for the Ft. Jackson project.
In mid August 2002, LOGAN and CERL personnel met at Ft. Jackson to discuss the demonstration project with Jerry Fuchs and Col. Johnson, the garrison commander. During the discussion, Col Johnson volunteered his personal residence to be the installation site. After a brief visit to his residence, it was decided to accept his offer to install the fuel cell there. Figure 1 and Figure 2 are photos of the fuel cell on its pad at Col. Johnson's residence. The back yard and patio are open to the right of the fuel cell.

Natural gas is conveniently located within 25 feet of the fuel cell pad, and the residential equipment room housing the hot water heater, electrical panel, and water source are also close and accessible.

Figure 1, at right, is a view of the installation showing the fuel cell sitting on a pad previously occupied by a 2-ton residential air conditioning unit. The fuel cell was rigged onto the pad with the assistance of a commercial fork truck. Note the compost bin to the right of the fuel cell. Screening shrubbery will be planted around the fuel cell.

Figure 1

Figure 2

The installation tasks and initial start of the Fort Jackson unit occurred on February 20, 2003. Figure 3, below, diagrams the fuel cell installation with utility interfaces including, natural gas, power and water in the adjacent residential room. The natural gas piping run is approximately 25 feet, the R/O water-piping run is approximately 25 feet, and the electrical and thermal recovery conduit runs are approximately 25 feet.

Ft. Jackson Installation Line Diagram

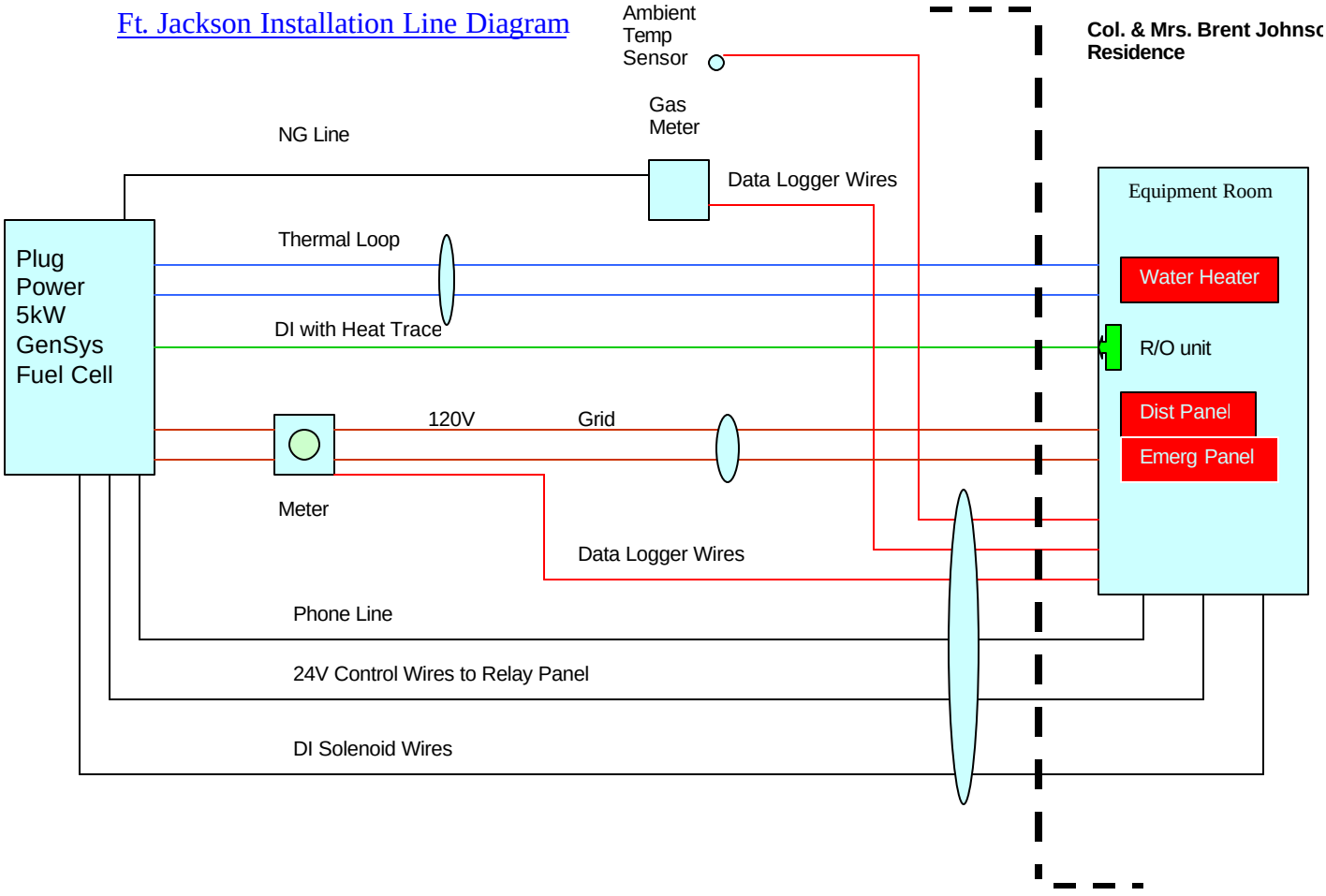


Figure 3

A Reverse Osmosis water filtration system will be installed in the equipment room to provide filtered process water to the power plant. Water will be piped to the fuel cell as indicated in Figure 3, above, and a heat strip will wrap the piping to prevent freezing.

The project required the procurement of two construction permits. A digging permit was issued by Ft. Jackson, and air quality permit was issued by the South Carolina Department of Health and Environment. Ft. Jackson personnel performed an asbestos investigation prior to allowing the project to begin. The differential between the estimated and the actual costs to install this project was not significant.

9.0 Electrical System

The fuel cell inverter in S/N 161 is the new MP-5, which adds a gird independent operating configuration to the grid parallel basic service for the first time in a Plug Power fuel cell. This capability is an important milestone in the development of the Gensys5 product and for the PEM Program itself, as it is a significant developmental step on the pathway to product commercialization. The unit has a power output of 110/120 VAC at 60 Hz, matching the residential distribution panel in the mechanical room with its connected loads at 110/120 VAC. In order to take full advantage of the improved inverter capabilities, LOGAN installed a two-pole wattmeter to record power delivered to both the existing power panel and the new critical load panel installed in the equipment room seen in Figure 6 below. Small non-critical electric outlets in the kitchen were transferred over to this panel to simulate the application. Some of these outlets provide power to the microwave oven, the toaster, and a light switch. In addition LOGAN installed a two-pole safety disconnect switch that permits the technician to safely bypass the fuel cell for maintenance without causing an inconvenience to the occupants of the residence. A schematic diagram of the disconnect switch necessary for the dual configuration MP5 inverter appears in Figure 4 below.

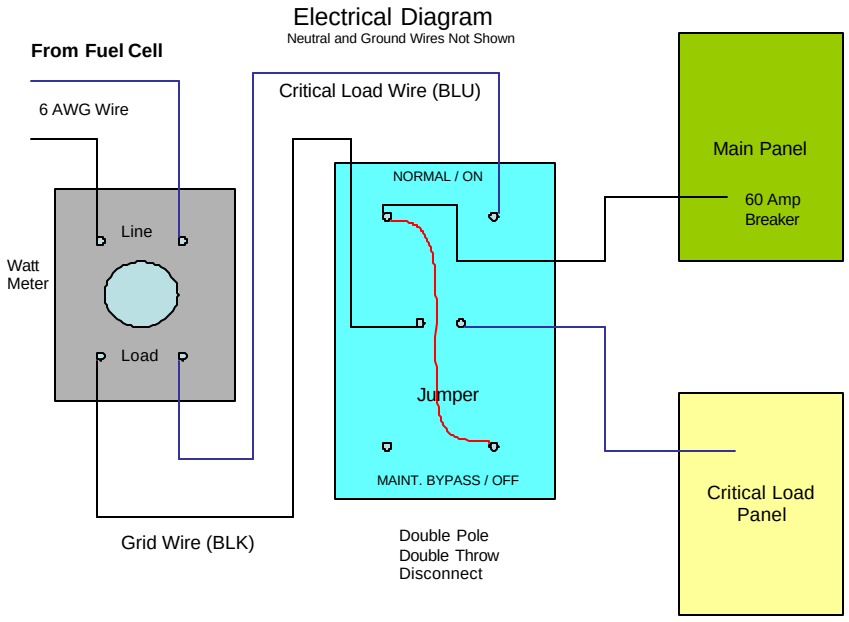


Figure 4

10.0 Thermal Recovery System

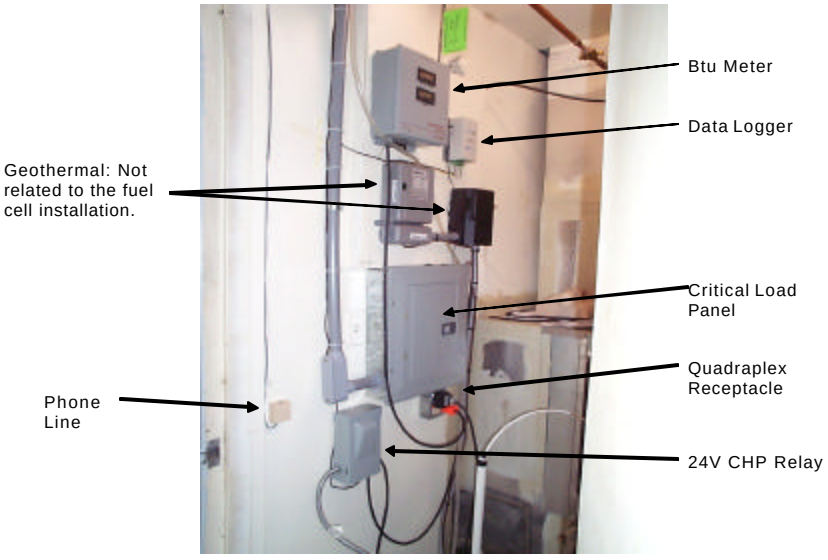
A Bradford Johnson Combi-Coil hot water heater with an internal heating coil replaced the existing hot water heater so that fuel cell waste heat could be provided to the residence thermal loads. While operating at a set point of 2.5 kWh, the fuel cell provides 7800 Btuh to the storage tank at approximately 140 degrees F. Fuel cell waste heat circulates between the fuel cell heat exchanger and the new hot water tank seen in the photo in Figure 5. The small pump, pictured at right, circulates a glycol solution between the fuel cell's heat exchanger and the hot water tank. This action transfers the fuel cell's waste heat into the tank as it flows through the coils wrapped circumferentially around the tank.

A BTU meter, seen in Figure 6 below, provides a continuous output of heat transferred into the thermal recovery system. The photo also shows the several other components that make up the thermal recovery system at this site.

Figure 5

Figure 6

Fuel Cell CL, 24V Relay, Btu Meter & Data Logger



11.0 Data Acquisition System

During the period October 2002 to August 2003, LOGAN's field service technicians performed their tasks with the support of a very rudimentary SCADA system developed by Plug Power for communicating with deployed units. This system provided one-way communication from each unit to Plug's customer support center, allowing the unit to call in overnight to download a data package and an operating status report. However, LOGAN realized very quickly that the system was inadequate and unreliable to provide the high level of communications support needed for its wide-ranging PEM demonstration program. At times a unit called in and provided only partial data or incorrect data. This created uncertainty in troubleshooting and further delay in restoring units to service. On other occasions a unit might fail to call in for a week or more frustrating the normal chain of events leading to a service advisory. While both Plug and LOGAN struggled early in the learning curve experience in developing cooperative service norms, the weakness of the SCADA system became a major source of dissatisfaction with Plug Power. Under the circumstances the only means of determining a unit's actual status was to make a service call to the site. However, the scope of LOGAN's PEM program required a better solution. Finally, in March 2003 an event occurred that gave Plug direct insight into the shortcomings of its SCADA system. After advising of a shutdown at Ft Bragg, Plug sent its own technician to the site because LOGAN's technicians were servicing other units. The technician flew from Albany, NY to Raleigh, NC and then drove out to the site. Upon arriving, the technician discovered that the unit was operating normally. Indeed the SCADA system was not.

This event was an important turning point for the LOGAN/Plug Power relationship and its cooperative efforts in achieving the goals of the PEM Demonstration Program. Six weeks later in early June, six representatives from LOGAN and eight from Plug Power met in Atlanta for two days of forthright discussions. The meeting focused on short-term methods and longer term solutions to improve remote PEM fuel cell performance. Most significantly Plug determined that it would institute immediate software changes and upgrades to insure the accuracy of fuel cell data communications. Plug also promised to initiate a design change to its SCADA system that would permit bi-directional remote communications with the fuel cell controller. More importantly Plug promised that LOGAN's technicians would be able to remotely troubleshoot, change set points and attempt restarts under some circumstances. Lastly they also promised that they would publish a daily status report covering all of LOGAN's units. By early August Plug began sending daily status reports, and by mid September Plug shipped LOGAN's technician's new control software that permits remote diagnostics, monitoring, troubleshooting, and restart capabilities. Since the introduction of this new service capability along with the adoption of improved service techniques to go with it, fleet performance, availability and operating costs have begun to show positive new trends.

An external four-channel data-logger, pictured in Figure 6 above, was installed at the site to record kW output, outside air temperature, Btu output. This data may be viewed in Appendix 1.

12.0 Fuel Supply System

Gas supply flows from a gas meter adjacent to the fuel cell pad as indicated in Figure 3. A regulator installed at the fuel cell gas inlet maintains the correct operating pressure at 10-14 inches water column (IWC). A new gas meter installed on the fuel cell supply records the gas volume consumed by the fuel cell. Natural gas is provided to the residence by the base and is not metered at the site by the gas company.

13.0 Installation Costs

Fort Jackson PEM Demonstration Program

Project Utility Rates		
1) Water (per 1,000 gallons)	$	1.31
2) Utility (per KWH)	$	0.065
3) Natural Gas (per MCF)	$	5.80

First Cost	**Estimated**	**Actual**
Plug Power 5 kW SU-1	$ 75,000.00	$ 75,000.00
Shipping	$ 1,800.00	$ 1,500.00
Installation electrical	$ 4,200.00	$ 2,182.00
Installation mechanical & thermal	$ 3,600.00	$ 6,500.00
Watt Meter, Instrumentation, Web Package	$ 800.00	$ 673.00
Site Prep, labor materials	$ 925.00	$ 1,024.00
Technical Supervision/Start-up	$ 6,500.00	$ 5,347.00
Total	**$ 92,825.00**	**$ 92,226.00**
Assume Five Year Simple Payback	$ 18,565.00	$ 18,445.20

Forcast Operating Expenses	Volume	$/Hr	$/ Yr	
Natural Gas Mcf/ hr @ 2.5kW	0.0328	$ 0.19	$ 1,501.59	
Water Gallons per Year	14,016		$ 18.36	
Total Annual Operating Cost				$ 1,519.95

Economic Summary			
Forcast Annual kWH		19710	
Annual Cost of Operating Power Plant	$	0.077	kWH
Credit Annual Thermal Recovery	$	(0.030)	kWH
Project Net Operating Cost	$	0.047	kWH
Displaced Utility cost	$	0.065	kWH
Energy Savings (Increase)		$0.018	kWH
Annual Energy Savings (Increase)		$349.48	

Explanation of Calculations:

Actual First Cost Total is a *sum* of all the listed first cost components.
Assumed Five Year Simple Payback is the Estimated First Cost Total *divided by* 5 years.
Forecast Operating Expenses:

Natural gas usage in a fuel cell system set at 2.5 kW will consume 0.033 Mcf per hour. The cost per hour is 0.033 Mcf per hour *x* the cost of natural gas to Jackson per Mcf at $5.80. The cost per year at $1501.59 is the cost per hour at $0.19 *x* 8760 hours per year *x* 0.9. The 0.9 is for 90% availability.

Natural gas fuel cell systems set at 2.5 kW will consume 1.6 gallons of water per hour through the DI panel. The total volume of water consumed at 14,016 gallons per year is 1.6 gph *x* 8760 hours per year. The cost per year at $18.36 is 14,016 gph *x* cost of water to Jackson at $1.31 per 1000 gallons.

The Total Annual Operating Cost, $1519.95 is the *sum of* the cost per year for the natural gas and the cost per year for the water consumption.

Economic Summary:

The Forecast Annual kWh at 19,710 kWh is the product of 2.5 kW set-point for the fuel cell system *x* 8760 hours per year *x* 0.9. The 0.9 is for 90% availability.

The Annual Cost of Operating the Power Plant at $0.077 per kWH is the Total Annual Operating Cost at $1519.95 *divided by* the forecast annual kWh at 19,710 kWh.

The Credit for Annual Thermal Recovery of $0.018/kWH equals 7800 BTU per hour thermal recovery at 2.5 kW *divided* by 3414BTU/kWh *multiplied* .20 recovery factor, *multiplied* by $0.039/kWh. As a credit to the cost summary, the value is expressed as a negative number.

The Project Net Operating Cost is the *sum* of the Annual Cost of Operating the Power Plant *plus* the Credit Annual Thermal Recovery.

The Project Net Operating Cost is the *sum* of the Annual Cost of Operating the Power Plant *plus* the Credit Annual Thermal Recovery.

The Displaced Utility Cost is the kWh cost of electricity paid by Ft. Jackson.

Energy Savings (cost) equals the Displaced Utility Cost *minus* the Project Net Operating Cost.
Annual Energy Savings (cost) equals the Energy Savings *x* the Forecast Annual kWh.

14.0 Acceptance Test

An 8-hour acceptance test was run on September 30, 2002 by the technician. It was the first successful start-up of the system. The hours allotted for each task in the report are standard and routine. Please see Appendix 2 for documentation of the test done by the technician.

Appendix

1) Monthly Performance Data

2) Acceptance Test Logs

3) Daily Work Logs

1) Monthly Performance Data

Monthly Performance Data
Fort Jackson

	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03
Run Time (Hours)	527	1239	1849	2569	3313	4057	4777	5499	6205	6945
Time in Period (Hours)	648	1368	2112	2832	3576	4320	5040	5784	6504	7248
Availability (%)	81.4%	90.6%	87.5%	90.7%	92.6%	93.9%	94.8%	95.1%	95.4%	95.8%
Energy Produced (kWe-hrs AC)	1,315.0	3,085.4	4,602.3	6,410.7	8,275.3	10,138.2	11,928.2	13,734.2	15,509.2	17,281.2
Output Setting (kW)	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Average Output (kW)	2.49	2.49	2.49	2.50	2.50	2.50	2.50	2.50	2.50	2.49
Capacity Factor (%)	40.6%	45.1%	43.6%	45.3%	46.3%	46.9%	47.3%	47.5%	47.7%	47.7%
Fuel Usage, HHV (BTUs)	17134620	42112166	62293703	85140455	109423659	134505271	159292768	183262785	205546830	228794492
Fuel Usage (SCF)	16,939.3	41,632.1	61,583.6	84,169.9	108,176.2	132,971.9	157,476.8	181,173.6	203,203.6	226,186.2
Electrical Efficiency (%)	26.2%	25.0%	25.2%	25.7%	25.8%	25.7%	25.6%	25.6%	25.8%	25.8%
Thermal Heat Recovery (BTUs)	-	4,340,097	4,926,779	5,052,405	4,985,484	8,146,885	7,566,722	7,665,637	7,767,943	7,555,971
Heat Recovery Rate (BTUs/hour)	0	6656	7818	7737	7475	12050	11089	11199	11309	10953
Thermal Efficiency (%)		17%	24%	22%	21%	32%	31%	32%	35%	33%
Overall Efficiency (%)	26.2%	42.4%	49.6%	47.8%	46.3%	58.2%	56.1%	57.6%	60.6%	58.3%
Number of Scheduled Outages	0	0	0	0	0	0	0	1	1	2
Scheduled Outage Hours	0	0	0	0	0	0	0	18	18	22
Number of Unscheduled Outages	3	4	5	5	5	5	5	5	6	6
Unscheduled Outage Hours	121	129	263	263	263	263	263	263	277	277

2) Documentation of Installation Tasks and Acceptance Test.

Installation Acceptance Test Report

Site: US Army Ft. Jackson...SU01-161

Installation Check List

TASK	Initials	DATE	TIME (hrs)
Batteries Installed	MH	10/24/02	2
Stack Installed	MH	10/24/02	3
Stack Coolant Installed	MH	1/30/02	1
Air Purged from Stack Coolant	MH	1/30/02	0.5
Radiator Coolant Installed	MH	1/30/02	3
Air Purged from Radiator Coolant	MH	1/30/02	1
J3 Cable Installed	MH	1/20/02	1
J3 Cable Wiring Tested	MH	1/20/02	0.5
Inverter Power Cable Installed	MH	1/20/02	0.5
Inverter Power Polarity Correct	MH	1/20/02	0.5
RS 232 /Modem Cable Installed	MH	1/27/02	0.5
DI Solenoid Cable Installed with Diode	MH	1/31/02	0.2
Natural Gas Pipe Installed	MH	1/9/03	8
DI Water / Heat Trace Installed	MH	1/31/02	4
Drain Tubing Installed	MH	1/31/02	1

Commissioning Check List and Acceptance Test

TASK	Initials	DATE	TIME (hrs)
Controls Powered Up and Communication OK	MH	2/4/03	4
SARC Name Correct	MH	2/4/03	1
Start-Up Initiated	MH	2/4/03	6
Coolant Leak Checked	MH	2/20/03	1
Flammable Gas Leak Checked	MH	2/20/03	1
Data Logging to Central Computer	MH	2/24/09	2
System Run for 8 Hours with No Failures	MH	2/24/09	8

3) Daily Work Log

Daily work log for Mike Harvell
LOGANEnergy Field Technician
October 1, 2002 through July 7, 2003

Date	Activity	Hours
10/2/2002	Planned and wrote scope of work.	2
10/7/2002	Went to Ft. Jackson, took measurements to make scaled drwgs. Met with Jerry Fuchs. Located the warehouse where RFC was. Inspected RFC.	7
10/8/2002	Made drawings. Started calling and talking with potential contractors. Faxed drawings. Began looking for fork lift.	5.5
10/10/2002	Continued calling contractors and faxing drawings. Made arrangements with the proper authorities on base to have access to Col. Johnson's home.	7
10/14/2002	Administration regarding contractors.	4
10/15/2002	Administration regarding contractors, rental company, base inspector.	4
10/16/2002	Went to base, talked with Mrs. Johnson about plans, rented trailer, tore down fence, uprooted bushes and hauled off. Also met with Gene Jones, chief inspector.	7
10/17/2002	Met Logan for breakfast with SCE&G. Picked up RFC and located on pad. Met with electrical contactor from NC. Met with Jerry Fuchs.	
10/21/2002	Met with Shealy Electric and Franklin D. Plumbing at the base. Marked site for PUPS to locate underground lines.	3
10/24/2002	Met Logan at Ft. Jackson. Spent afternoon leveling RFC and installing stack. Worked on administration related to the installation.	8
10/25/2002	Printed manuals for installation. Studied thermal loop installation. Tried to motivate contractors to get prices in.	4
10/28/2002	Continued studying installation and getting more drawings and calling contractors.	4
11/11/2002	Ft. Jackson administration: Calling and talking with contractors Making drawings they could understand, and getting clarification on thermal loop issues.	6
11/12/2002	Made a one-line drwg. To make sure we got all the wires in the	3

	right conduits and talked further with contractors on timing.	
11/26/2002	Fired the plumbing contractor for dragging the job out. Called two new contractors and took them out to Ft. Jackson to look at the job.	5
12/2/2002	Priced landscaping supplies.	1
12/3/2002	Went to Ft. Jackson to discuss landscape design with Col. Johnson's wife.	2.5
12/4/2002	Began purchasing landscape supplies. Nailed down plumbing contractor.	3.5
12/5/2002	Phone calls to contractors and A.O. Smith.	0.5
12/6/2002	Bought landscape supplies and set fenceposts in concrete.	6.5
12/10/2002	Picked up and delivered boards from Lowes to build fence.	2.5
12/11/2002	Built fence.	7
12/12/2002	Gathered replacement bushes and delivered. Finished fence construction.	3
12/16/2002	Phone calls to contractors.	0.5
12/18/2002	Met new plumber at site to go over the project and begin work. Let electrician from Fayetteville go and found another electrical contractor.	7
12/19/2002	Got electrical contractor started. Painted fence. Discovered there were 3 more permits to get and began working on them.	8.5
12/20/2002	Gathered and sent air quality data to environmental dept at the base. Put second coat of paint on fence and worked with plumbing contractor.	8
12/23/2002	Phone calls to contractors to discuss work and holiday schedule.	0.5
1/2/03	Worked with electrical contractor to figure out wiring of disconnect, watt meter, and other issues. Also gathered data for Air Quality Permit. Drew and faxed wiring diagram to Dick for his input.	8.5
1/7/03	Drove by Ft. Jackson on the way to Bragg to communicate with colonel's wife regarding getting into the house electrical panel.	1
1/9/03	Worked with electrical and plumbing contractors. Electricians finished their work. Plumber still has much to do.	9
1/10/02	Col. Johnson called regarding some receptacles that were not working. Got electrician back out to check and he found a GFI receptacle tripped	2

	on the back porch.	
1/13/03	Went to site to begin commissioning the fuel cell for operation. Tightened up cell stack and cables, began charging batteries,etc. Plumber put in a new water heater. When he turned the NG back on, something happened to the regulator and it would not work, so after consulting with the base we realized we could get it replaced faster than they could. So Meetze Plumbing bought one and replaced it and got reimbused by the base -- but that little diversion cost us the whole afternoon.	9.5
1/14/03	Spent day with Sam at Ft. Inspected plumber's work.	8
1/20/03	Spent most of day troubleshooting battery/inverter voltage issue. Could not get more than 24 volts on batteries after having 45 volts the other day. Still waiting on plumber to move along.	8.5
1/27/03	Charged up batteries most of the day and finally got the SARC to boot up. Entered data into SARC and it held OK. Plumber continued work on the thermal loop.	8
1/28/03	Changed wiring on K1 relay to prevent current inrush problems. Installed new 1.7 software. Still had problems getting power to critical load panel. Never could get it to work in mode 2 correctly.	8
1/29/03	drove to Columbia to assit Mike at Ft. Jackson	12
1/30/2003	Worked with Keith to reflash software and add a .rom file that PLUG had sent me. They now inform me that the critical load panel will not be powered up until the RFC starts for the first time. We then began filling fluids.	8
1/30/03	worked with Mike at Ft. Jackson set up shelter and started to fill fluids we reflashed the new software but it didn't appear to resolve the critical load issue	6
1/31/2003	Continued filling fluids until done. Then we pulled all the control wires for 24V relay, DI solenoid, data logger, and phone line. Hung the Btu meter and commissioned the DI panel (1 hr. flush). Made 2 trips to Lowes for parts. Filled the thermal loop. Plumber is done for the most part. Will go for a start next week.	9
1/31/03	Finished filling fluids and pulled wires for controls connected DI solenoid and flushed then filled tank was going to attemp start but could not get a definitive answer from Plug regarding the issue of the critical load panel	8
2/4/03	Started the fuel cell, but the inverter did not allow the critical load panel to be energized when the fuel cell was down. FC operated well. PLUG is sending another inverter chip.	8
2/6/03	Installed chip in inverter. Received electric meter, but it did not have pulse wires. Began talking with Patrick at PEPCO to see if the meter can be programmed in the field. Worked on running wires to the various data	8

	logger components. Talking with Lisa Potter about CHP wiring.	
2/7/03	Receive new CHP drawings from Lisa Potter that will change our wiring Began buying components for the new wiring scheme. Had to order the relay. Spent most of the day wiring the Btu meter.	8
2/10/03	Started FC, but it ran rough. Nothing related to the inverter would level out. PLUG thought the chip may have been programmed or installed improperly. Left it running overnight, to no avail.	9
2/11/03	Got to the site and saw that the FC had not improved. I shut it down and tried reseating the inverter chip, as well as installing the old one, but the inverter never acted the way it should. PLUG sending another more robust chip. Wiring of the CHP loop completed. Therminol was low, so I had to drive home to get some. Tripped the 60 amp breaker on Col. Johnson's main panel. That was another "red flag" regarding the inverter.	8
2/12/03	Spent the day with Logan, McClelland, & Williams troubleshooting fuel cell and making adjustments to thermal loop.	9
2/12/03	met with Dick, Mike and Sam and went to Ft Jackson to review CHP installation	8
2/13/03	Continued troubleshooting focusing on the inverter and trying to understand the inner workings thereof. Went for a start after re-flashing the SARC, but not change. Asked PLUG to send someone down.	9
2/13/03	met around the pool to discuss problems with Ft. Jackson unit and to train with Dick's software went back to Ft. Jackson and worked to remove stove from critical load panel	9
2/15/03	Designed and built pre-filter rack for Fort Jackson.	2
2/18/03	Met Jon Kinsey from PLUG and we spent the day troubleshooting the RFC by starting it and seeing if manipulating parameters could change its poor performance. Diagnosed it as an LTS catalyst problem or PROX issue.	9
2/20/2003	Received catalyst and PROX and installed both. Then went through LTS catalyst reduction for 6 hrs. Started up around 7:30 pm. Looked good	8
2/21/2003	Rechecked operation today and found some very minor gas leaks. Stopped all but one that is right next to the sensors. Not enough to trip the sensors. PLUG sending me new gasket. Found slight drip from E-wheel that might can be repaired with RTV. PLUG sending a spare just in case.	6
2/24/2003	Assembled and installed pre-filters. RFC running fine. DI tank filling very slowly, raised water pressure to max 55psi.	5
2/26/2003	RFC shut down due to fire dept. shutting the gas off when the Johnsons smelled gas the night before. Leak was found in some old connections near the water heater (not in anything we did). Was attempting to start up	3

	the unit when an e-stop shut the system down and the critical load lost power. Another attempt ended the same way. Decided to leave it off and consult with Plug about the inverter issue.	
2/27/2003	Discussions with Plug over the events of yesterday. They decided to send someone down.	2
3/3/03	Landscaping	5
3/4/03	Inverter troubleshooting with Garnett from PLUG. Found a bad battery and replaced. Set inverter to Mode 3 to charge the batteries even when fuel cell is off. These two changes should eliminate accidental isolation of the critical load panel. Completed landscaping except for hauling off trash.	10
3/6/03	Studied data logger programming. Was having problems connecting to logger and found that I have the wrong kind of USB serial adapter.	4
3/7/03	Went to site to check on fuel cell. All looked good. Booted up data logger using old laptop and null modem cable. PEPCO is sending me a new KV2 meter with I/O board. The meter I have cannot be programmed to send pulses to data logger.	3
3/12/03	Started RFC after changing RO filter (low DI tank shutdown). Laid more landscape pavers and planted grass. Plumber swapped inlet and outlet lines on the water heater per Dick's request.	7
3/13/03	Started thermal recovery mapping, but thermostat switch or CHP relay seems to be wired incorrectly. Consulting with plumber about that.	7
3/14/03	Thermal recovery mapping ended in RFC shutdown on low DI tank after 2 hours of testing. Restart fuel cell. RFC was at 5kW when shutdown occurred.	7
3/20/03	Changed DI filter. Swapped wires on water heater thermostat because circulator pmp not working.	3
3/31/03	Changed RO filter. Collected and sent water samples. Restarted RFC.	2.5
4/4/03	Checked in to see how unit was doing. All looked well. Downloaded logger data and SARC data.	2
4/11/03	Checked DI filters -- OK. Removed Btu components to be shipped back for re-calibration.	3
4/14/03	Changed RO filter and restarted unit.	5
4/17/03	Checked DI water flow. Looked good.	1.5
4/24/03	Checked system out. Stack didn't look so great, but DI system was still working fine.	2
5/1/03	Installed new electric meter and Btu circuit boards.	2.5

5/6/03	System had not been running well over the last couple of weeks. Today it was putting out 1 kW. I shut system down to install SARC v1.23 software. Started back up and it was doing 2.5kW, but VDC was was low. Fixed a problem with the electric meter portion of the data logger. Blew a fuse on solenoid 2 (DI system) when I pinched a wire in the door. Found another fuse on the SARC that was not in use and got it working again.	7
5/13/03	Shut down on 5/7. Plug said a new cell stack is needed. Installed it and restarted system. All looked well.	10
5/30/03	Checked on system. All is well. DI flow is good. Entered new call out parameters for Plug. Collected monthly data.	3
6/9/03	Fuel cell running fine. Replaced all 4 filters. They were discolored with what appears like iron.	3
6/18/03	Checked in. Tested iron at roughly 0.05 ppm. Checked on DI flow -- OK.	2
6/27/03	Checked in. Everything looks good.	2.5
7/7/03	Checked system and downloaded data.	2.5

Aug-03

Ft. Jackson

Date	PP S/N	Activity	Hours
8/11/03	SU161	Sump pump was clogged and leaking wastewater from DI panel into utility room. Unclogged it and checked out system.	2.5
8/21/2003		Took Vince Enriquez to site. Changed all 3 water filters and checked out system.	2.5

Sep-03

Ft. Jackson

Date	PP S/N	Activity	Hours
9/10/03	SU161	Gathered data. Checked out system.	1

Oct-03

Ft. Jackson

Date	PP S/N	Activity	Hours
10/8/03	SU161	Monthly data downloads.	2
10/15/2003		On site with Nick Bell. Laptop stolen night before. Got son's laptop, Plug e-mailed software, tried connecting to fuel cell but ran into lots of problems.	**6**
10/16/2003		Got laptop working, changed stack, did inverter retrofit, upgraded software, did 12,000 kWH maintenance, replaced 50' of DI tubing.	9
10/17/2003		Started fuel cell. Changed all DI filters.	6
10/21/2003		Checked system out. All OK.	2
10/23/2003		Dedication.	6

Nov-03

Ft. Jackson

Date	PP S/N	Activity	Hours
	SU161		
11/4/03		Shut systems down, loaded V1.27 s/w and restarted. Also collected monthly data.	3
11/20/03		Switched the polarity on the phone line to eliminate a problem with the unit calling out. Polarity corrected.	5
		Mike Harvell tested the phone line and found the polarity was reversed. Now receiving Stats and Event files, still no system data. Chris Ashley will call the system today to verify proper data logging setup.	

Dec-03

Ft. Jackson

Date	PP S/N	Activity	Hours
12/17/03	SU161	Changed carbon and RO filters. Gave Ed some training.	4